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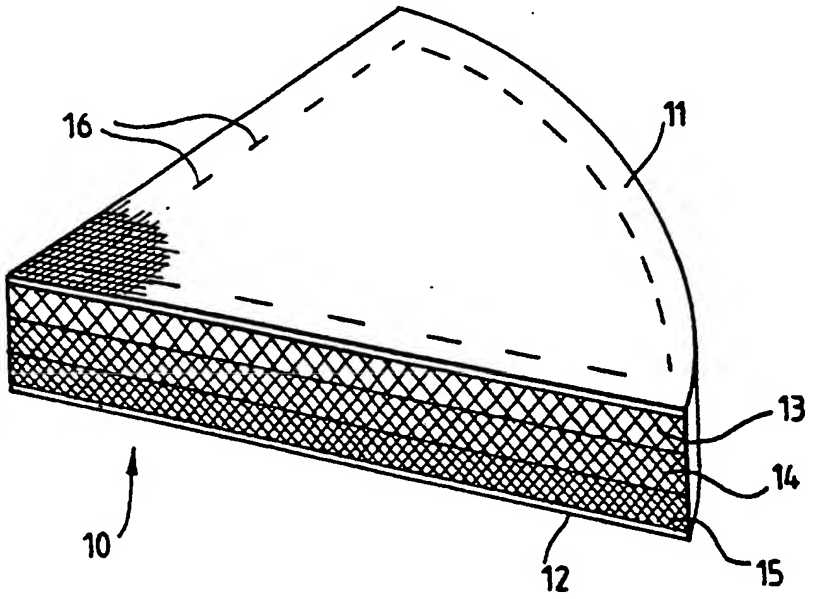
(54) Title: CATCHMENT PACKS



(57) Abstract

A catchment pack suitable for use in an ammonia oxidation reactor has a predetermined geometric shape and comprises two or more catchment pack segments (10) located in planar edge-to-edge relationship one with another, each of said catchment pack segments (10) comprising support gauze segments (11, 12) interleaved with one or more pads (13, 14, 15) of wire formed from a getter material, such as palladium-gold alloy.

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CATCHMENT PACKS.

This invention relates to a catchment pack containing layers of material such as are typically used as catalyst catchment or getter means in nitric acid production plants.

In the industrial production of nitric acid, it is common practice first to prepare nitric oxide by passing a mixture of ammonia and air at elevated temperature through an oxidation catalyst comprising one or more gauzes woven from wire comprising an alloy of platinum and rhodium. In use, platinum and, to a lesser extent, rhodium are themselves converted to their oxides whch are volatile at the plant operating temperatures obtaining and are, in consequence, carried away in the nitric oxide stream to be eventually deposited on cooler parts of the plant downstream of the catalyst or lost altogether to atmosphere.

In order to reduce these losses of platinum and rhodium to an acceptable leve catchment gauze packs have been developed for insertion in the catalytic reactor immediately downstream of the catalytic gauze or gauzes. Typically, such packs consist of interleaved gauzes woven from, respectively, a getter material and a support material. A suitable and commonly-used getter material is an alloy of palladium and gold, for example 20% gold-palladium, and a suitable support material is an oxidation-resistant stainless steel such as Megapyr 2 (Registered Trade Mark).

A sectional view of a typical ammonia oxidation reactor is shown in Figure X of the accompanying drawings. In Figure X, the catalytic platinum-rhodium gauzes are shown at 1 supported on a catchment pack 2 of interleaved stainless steel support

and gold/palladium getter gauzes. The entire catalyst/catchment gauze assembly is clamped together with a gasket 3 between reactor flanges 4. Heavy support bars 5 are provided across the area of the reactor. Figure Y of the accompanying drawings shows a detail of an alternative means of assembling and supporting a catchment gauze pack in which the gauzes are slightly smaller in diameter than the reactor, thus allowing a peripheral expansion space 6, and are supported on a coarse gauze 7 fabricated from, for example, "Iconel" (Trade Mark) steel itself supported on the heavy support bars. Additionally, in this arrangement, the uppermost stainless steel gauze is oversize relative to the remainder of the getter and support gauzes and is folded over peripherally and beneath the said remainder of the gauzes at 8 so that the entire catchment gauze pack may then be handled as a unit. This is particularly desirable because, although the getter material is capable of retaining its gettering activity over a period amounting to twice or more times the useful lifetime of the catalytic gauzes,(known in the art as a "campaign"), in use the getter material suffers embrittlement leading to failure of the gauze on movement which usually means in practice that it needs to be discarded early, that is, at the end of a campaign when the reactor is dismantled to renew the catalytic gauzes, or earlier if there is some other reason requiring the reactor to be dismantled. Clearly, the ability to handle the catchment pack as a unit which is fairly rigid tends to mitigate this drawback but, particularly on low- or medium- pressure oxidation plants which may

have a reactor diameter in the region of 3 metres or more, there is an inherent degree of flexibility in the pack which causes embrittled gauzes to fail on handling. Additionally, of course, a catchment gauze pack suitable for such a large diameter reactor is a particularly heavy and bulky item to store in security, to transport and generally to handle.

It is, therefore, an object of the invention to provide a catchment pack which is substantially rigid, is easy to store and transport and may readily be removed from and replaced in a catalytic reactor such as an ammonia oxidation reactor without failure of the getter material.

We have now found that catchment packs may comprise a plurality of pack segments, for example sectors, which may be located in contiguous relationship one with another in a reactor to provide together in effect a catchment pack extending over substantially the entire surface area of the catalytic gauze.

According to one aspect of the invention, we propose a catchment pack segment suitable for use in an ammonia oxidation reactor and adapted to be located in planar edge-to-edge relationship with one or more further catchment pack segments to form a composite catchment pack having a predetermined geometric shape, the pack segment comprising support gauze segments interleaved with one or more pads of wire formed from a getter material.

According to a second aspect of the invention, we propose a method of making a catchment pack segment, comprising interleaving support gauze segments of a required shape with one or more pads

of wire formed from a getter material and of a required shape, and securing the segments and the or each pad together.

This invention also includes a catchment pack when made from a plurality of segments according to the first or second aspects of the invention, wherein the predetermined shape is preferably regular.

The wire pad may be in the form of knitted wire or randomly oriented wire either of which can be compressed. By knitted wire is meant interlocked loops of wire.

If the pad is in the form of knitted wire, this may be formed as a continuous tube, which can be slit longitudinally, and opened out to form a single knitted layer. The weight of metal of a single such knitted layer can be in the range 50 to 1500 g/m^2, preferably 150 to 1300 g/m^2.

Where the catchment pack is intended for use in a catalyst reactor such as an ammonia oxidation reactor, the catchment pack segment comprises at least two gauze segments made of a support material such as oxidation-resistant stainless steel, for example Megapyr 2, and interleaved between the or each two adjacent support gauzes, one or more wire pads made of a getter material such as an alloy of palladium and gold, for example 20% gold-palladium, although other getter materials may be used, particularly less robust materials or materials which in use become less robust.

Where more than one pads of getter material are used each pad is preferably of different gauge wire and of different voidage. This is because the upstream portion or portions of the catchment pack absorb relatively more of the platinum and rhodium and therefore need to be more robust; they also tend to swell more

in use. Also, the downstream portion or portions should have less voidage, subject to avoiding substantial increase in the back presusre, so as more effectively to getter platinum and rhodium still remaining in the gas stream after passing through the upstream portion or portions.

The diameter of the wire should be in the range 0.05mm to 0.4 mm. The preferred range is from 0.06 to 0.25 mm for metal weight optimised according to the position in the pack.

Production, transportion and storage of catchment pack segments according to this invention, is easier than the production, transportation and storage of conventional catchment packs in the form of pads of wire which extend across the entire area of the ammonia oxidation reactor, particularly using more than one pad of wire for which it is necessary to compress the pads evenly together over a large area and secure them between support gauzes. Wire pad catchment packs, being relatively inflexible (as opposed to gauze catchment packs), could not be rolled up to form a tube for the purposes of transportation and storage and hence the invention imparts a considerable practical advantage in use.

Where different gauge wire is used in adjacent pads, the

upstream pad is formed from wire typically having a diameter in the range 150-250 microns and the downstream pad is formed from wire typically having a diameter in the range 50-100 microns Intermediate pads may be formed from wire typically having a diameter in the range 100 to 150 microns. The thickness of each pad and of the total catchment pack is dependent upon the operating pressure and other parameters of the particular ammonia oxidation plant.

A pack segment according to the invention may have the form of a sector, for example a semi-circle or a quadrant, or another shape which, when located in planar contiguous relationship with one or more further pack segments (which further segment or segments may or may not have the same or similar shape to the first segment) provides a catchment pack having a predetermined, e.g. regular, geometric shape. It is normally preferred that the regular shape is circular, and other shapes may be used for example rectangular, square or polygonal, for example hexagonal.

This invention also includes methods of making catchment pack segments. For example, a catchment pack segment according to the invention may be made by assembling or superposing segments of the required material and shape in the required order and securing them together to form a pack. Securing may be achieved for example by folding one or more marginal portions of an outermost support gauze over an edge of the assembly (in which case at least one support gauze segment should be oversize relative to the remainder to provide a suitable marginal portion), or by welding, riveting, tying with wire and the like.

Individual pack segments according to the invention may be located in planar contiguous relationship one with another to form a circular or other regular shaped arrangement for location in a catalyst reactor, although we have found that for many purposes it is convenient to hingeably connect the segments in such a way that they can themselves be folded for transportation and storage so that the entire catchment pack assumes the shape and area of the individual segments thereof. Alternatively, individual segments may be temporarily held one with another in the reactor, hingeably or otherwise.

For locating in a catalyst reactor, for example, the folded pack is placed on the the support bars or other support means with the peripheral edge of the folded pack adjacent to the inner edge of the reactor body and the pack is unfolded so that individual catchment pack segments lie in planar contiguous relationship one with another to substantially cover (except for a peripheral expansion gap and small gaps between hinged edges of adjacent pack segments and the like) the cross-sectional area of the reactor. Embodiments of the invention will be described by way of example with reference to Figures 1 to 3 of the drawings. In these figures:

Figure 1 shows a perspective view of a catchment pack segment in the form of a quadrant, partly cut away to show a section through the pack;

Figures 2A to 2E show how four quadrants as shown in Figure 1 may be hingeably connected and folded; and,

Figures 3A to 3J show various ways of assembling catchment pack segments to form catchment packs having a regular geometric shape.

Referring to Figure 1, a catchment pack segment 10 has the form of a quadrant. It consists of outermost support gauzes 11, 12 secured between which are three wire pads 13, 14 and 15 formed from knitted and compressed wire formed from a getter material such as palladium gold alloy. Pad 13 is formed from the heaviest gauge (200 microns) wire and is lightly compressed; pad 14 in turn is formed from lighter gauge (125 microns) wire and is relatively more compressed. Pad 15 is formed from the lightest gauge wire (75 microns) and is compressed the most. The pads and support gauzes are secured together with staples 16 to provide a pack segment. Pad 13 is the upstream pad when located in the reactor next to the catalyst gauzes.

One way of higeably connecting four catchment pack segments such as shown in Figure 1 is shown in Figures 2A to 2E. In Figure 2A four catchment pack segments S1, S2, S3 and S4 are shown hingeably connected at mutually adjacent edges S1 and S2, S1 and S4, and S3 and S4 of the segments respectively. Hingeable connection are shown at SS. Figure 2B illustrates the first fold (i.e. segments S1 and S2 together folded on segments S3 and S4) and Figure 2C illustrates the second and third folds (i.e. segments S3 and S2 are respectively folded back upon segments S4 and S1). Figure 2D illustrates the resulting folded catchment pack segments, and Figure 2E shows the pack segments unfolded to provide a catchment pack as located in, for example, a catalylst reactor. Option-

ally, the segments S2 and S3 can be held together, for example by stitching, as shown in Figure 2E at SS (the original hingeable connections being omitted for the sake of clarity.

One pack segment according to the invention may be hingeably connected with another by any convenient method, for example by stitching, by use of hoops or by hoops and rods. The material from which hoops or other hingeing means are made should obviously be capable of withstanding conditions obtaining in whatever use the catchment pack is to be put and should preferably be reasonably flexible for ease of folding and non-interference with, for example, adjacent catalyst gauze. Optionally, hingeable connections may be made or broken, e.g. by inserting or removing a rod from a series of hoops, on site.

Although the invention has been particularly described with reference to a catchment pack segment formed in the shape of a quadrant it is to be appreciated that the invention provides a pack segment comprising a plurality of segments which may be assembled by stacking one or another and securing the resulting stack so that the individual segments are held in fixed relationship one with another. Alternative embodiments of the invention are illustrated in Figure 3 of the accompanying drawings, in which are shown ways in which pack segments may be located in planar contiguous relationship one with another to provide a catchment pack having a regular geometric shape. Individual pack segments of Figure 3 may optionally be hingeably connected to an adjacent segment.

Catchment packs may have diameters of up to several metres and their provision in segments optionally hingeably connected together as above described saves a considerable amount of space

during transportation from a manufacturer to the site, for example a nitric acid plant. Furthermore, in certain cases, transportation costs are calculated on the "girth" of the article and the invention results in a considerable reduction in girth.

A catchment pack consisting of segments according to the invention may be readily installed in a plant and may also be readily removed, either by removing individual pack segments or by folding segments if they are hingeably connected and removing the entire pack, without damaging the getter material. The removed pack may easily be handled, stored in security during plant maintenance and the like, or transported for the purpose of refining and platinum recovery.

CLAIMS

1. A catchment pack segment suitable for use in an ammonia oxidation reactor and adapted to be located in planar edge-to-edge relationship with one or more further catchment pack segments to form a composite catchment pack having a predetermined geometric shape, the pack segment comprising support gauze segments interleaved with one or more pads of wire formed from a getter material.

2. A catchment pack segment according to claim 1, wherein the support gauze segments and the or each wire pad have at least when assembled substantially identical shape and area and are held in fixed, superposed relationship one with another.

3. A catchment pack segment according to claim 2, in which the support material comprises an oxidation-resistant stainless steel.

4. A catchment pack segment according to claim 2, in which the getter material comprises an alloy comprising gold and palladium.

5. A catchment pack segment according to any preceding claim in which the segments and the or each wire pad have the form of a sector of a circle.

6. A catchment pack segment according to claim 5, in which the sector is a semi-circle.

7. A catchment pack segment according to claim 5, in which the sector is a quadrant.

8. A catchment pack segment according to any preceding claim, wherein the wire pad is in the form of knitted or randomly oriented wire.

9. A catchment pack segment according to claim 8, wherein the wire is compressed.

10. A method of making a catchment pack segment, comprising interleaving support gauze segments of a required shape with one or more pads of wire formed from a getter material and of a required shape, and securing the segments and the or each pad together.

11. A method according to claim 10, in which an outermost support gauze segment is oversize relative to the remainder of the segments to provide a marginal portion which is folded over an edge of the superposed assembly to effect securing.

12. A catchment pack having a predetermined geometric shape and comprising two or more catchment pack segments located in planar edge-to-edge relationship one with another, each of said catchment pack segments comprising support gauze segments interleaved with one or more pads of wire formed from a getter material.

13. A catchment pack according to claim 12, in which the pack segments and the or each pad have substantially identical shape and area.

14. A catchment pack according to claim 12, in which at least two of the pack segments have a different shape and area from each other.

15. A catchment pack according to claim 12, 13 or 14, in which at least two adjacent segments are hingeably connected.

16. A catchment pack segment constructed and arranged as herein described with reference to and as illustrated in Figure 1 of the drawings.

17. A catchment pack constructed and arranged as herein described with reference to and as illustrated in any of Figures 2 and 3 of the drawings.

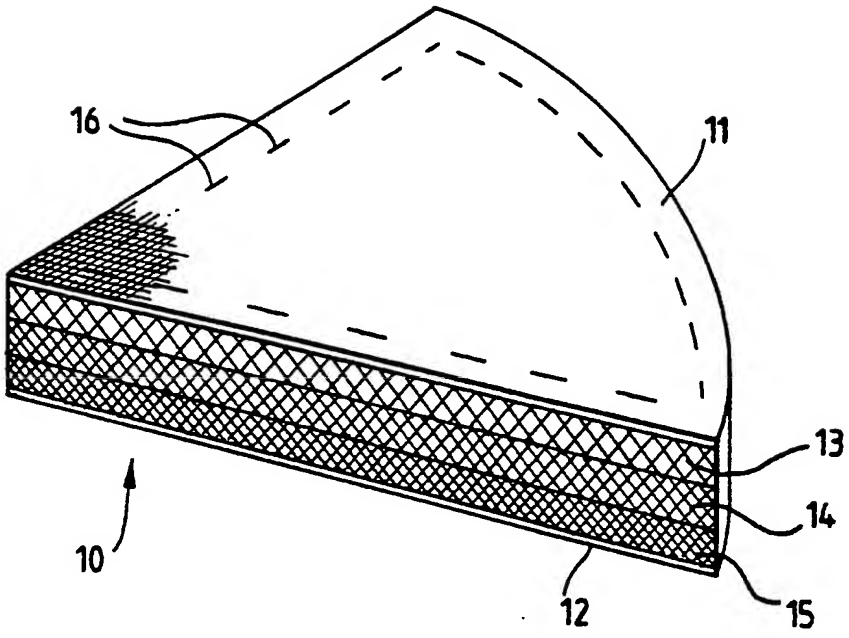


FIG.1.

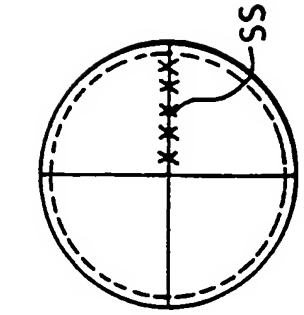


FIG.2E.

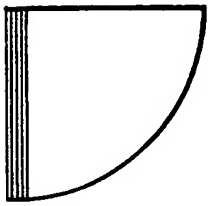


FIG.2D

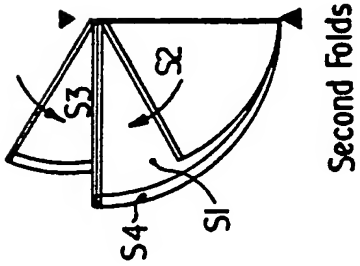


FIG.2C.

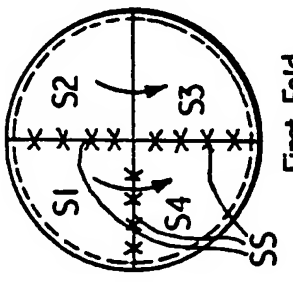


FIG.2B

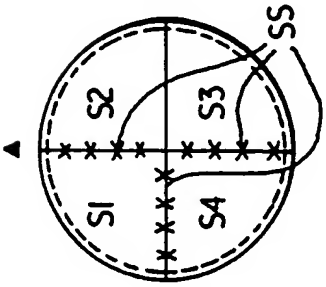


FIG.2A.

FIG.X. (PRIOR ART)

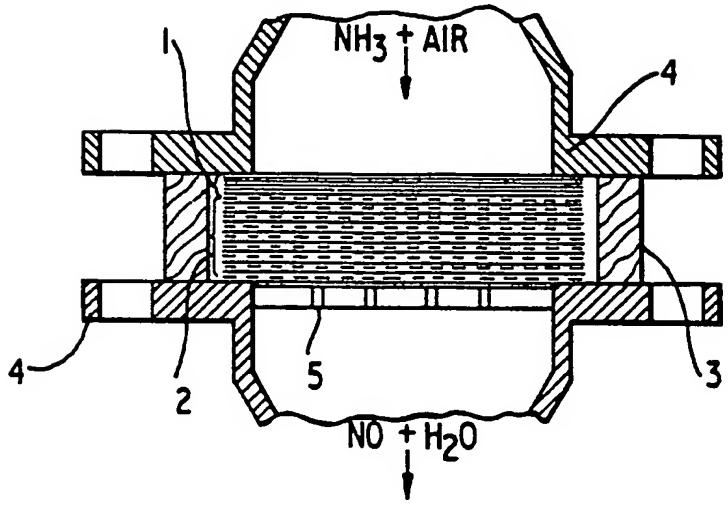
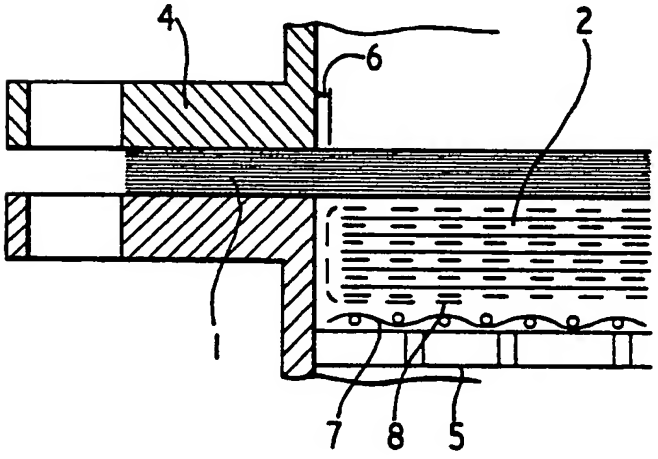


FIG.Y. (PRIOR ART)



LEGEND FOR GAUZES 2:-

- - - - - - -STAINLESS STEEL

————————Au/Pd

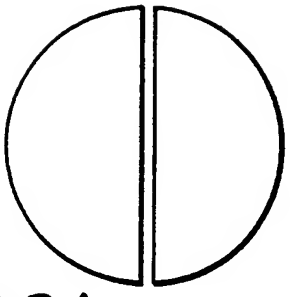


FIG.3A

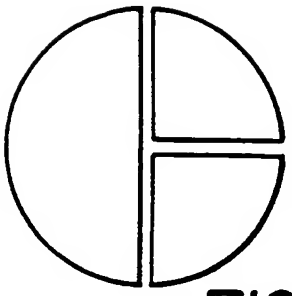


FIG.3B.

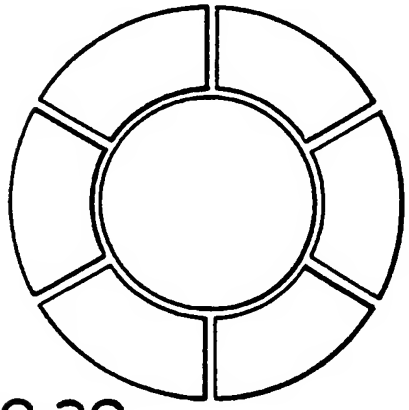


FIG.3C.

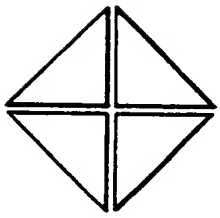


FIG.D.

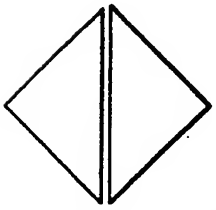


FIG.3E.

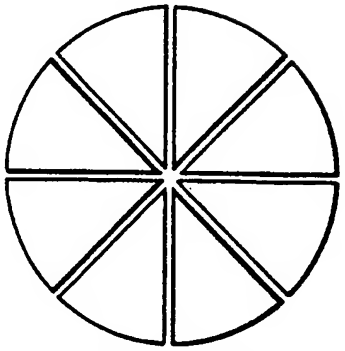


FIG.3F.

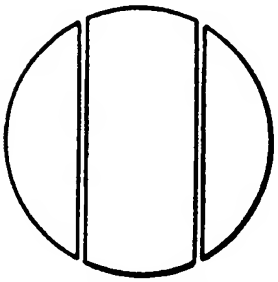


FIG.3G.

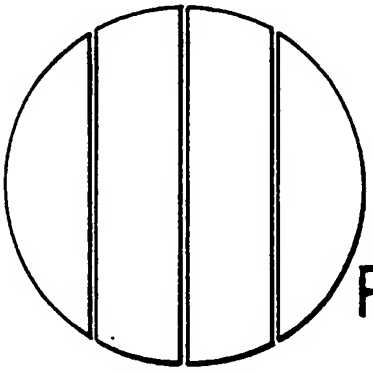


FIG.3H.

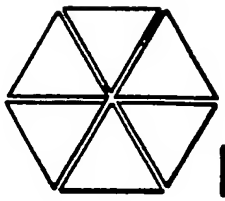


FIG.3J.

INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 84/00428

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) *

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC[4]: C 01 B 21/26; B 01 J 19/00

II. FIELDS SEARCHED

Minimum Documentation Searched 7

Classification System	Classification Symbols
IPC[4]	C 01 B B 01 J B 01 D

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched 8

III. DOCUMENTS CONSIDERED TO BE RELEVANT *

Category *	Citation of Document, 11 with indication, where appropriate, of the relevant passages 12	Relevant to Claim No. 13
X	GB, A, 2050189 (JOHNSON MATTHEY & CO.) 7 January 1982, see the whole document	1-17
E	GB, A, 2141042 (JOHNSON MATTHEY PUBLIC LIMITED COMPANY) 12 December 1984, see the whole document	1-17

* Special categories of cited documents: 10

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

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"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
12th August 1985	20 DEC. 1985
International Searching Authority	Signature of Authorized Officer
EUROPEAN PATENT OFFICE	G.L.M. Kruydenberg

Form PCT/ISA/210 (second sheet) (January 1985)

ANNEX TO INTERNATIONAL SEARCH REPORT

INTERNATIONAL APPLICATION NO. PCT/GB 84/00428 (SA 8595)

This Annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 17/12/85

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Patent document cited in search report	Publication date	Patent family member(s)		Publication date
GB-A- 2050189	07/01/81	BE-A-	883056	18/08/80
		FR-A-	2455557	28/11/80
		DE-A-	3016979	13/11/80
		JP-A-	56015822	16/02/81
		US-A-	4351887	28/09/82
		SE-A-	8003188	04/11/80
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GB-A- 2141042	12/12/84	None		